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Ovine Body Composition as Influenced by Live Weight

Wallace Jon Koester

OVINE BODY COMPOSITION AS INFLUENCED BY LIVE WEIGHT

BY

WALLACE JON KOESTER

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Adviser | Date

Head, Animal Science Department | Date

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TABLE OF CONTENTS

LIST OF TABLES

Table		Page

LIST OF FIGURES

LIST OF APPENDIX TABLES

INTRODUCTION

Breeders are looking today for larger, growthier animals which will produce a fast gaining market lamb. The market animals must be able to reach a desirable weight with a correct amount of finish. The weight at which these lambs are marketed influences average daily gain and feed efficiency. This market weight often depends upon the availability and cost of feed. When market prices look favorable for the future, the producer tends to put additional weight on his lambs in order to obtain a greater total return. The producer is usually encouraged to market his products at weights which maximize feed efficiency and meat production.

During the last five to ten years, trimness has become very important in all species of livestock. Size and scale of the market lamb has increased with a trimmer type of lamb produced. Growthy lambs tend to gain more rapidly and produce a leaner, trimmer carcass which may sell at a premium. The packer's slaughtering and processing costs are prorated on a per head basis; therefore, it costs the packer the same amount to slaughter and process a 90 pound lamb as it does a larger one. With new techniques for processing such as prepackaging, it may become desirable for the packer to purchase lambs which are heavier than current market weights. Lambs which are trim, heavily muscled and have a high percentage of edible portion are being produced at these heavier weights. The production of more lambs of this type will assure a greater return on investment to both the packer and producer.

This study was designed to evaluate the influence of live weight on carcass composition, particularly edible portion.

REVIEW OF LITERATURE

The evaluation of a meat animal or its carcass is generally based upon the quantity and quality of the lean meat. Lean quantity may be estimated in a carcass by the amount of internal and external fat and overall muscling. This lean quantity may be expressed as a percent of the carcass weight. The estimated lean quantity of the live animal is related to the market value of that animal. Lean quantity may be influenced by live weight.

Live weight is probably the oldest and most often used method of determining the time of slaughter. Slaughter weight is an important factor influencing the return over feed and production costs.

Data collected by the South Dakota Crop and Livestock Reporting Service (1969) showed that slaughter weight and price have increased through the years. The average yearly market weight in the last 20 years ranged from a low of 97 pounds in 1953 to a high of 108 pounds in 1968. Southam and Field (1969) reported that packers received a larger quantity of heavier lambs in the fall and winter than in the spring and summer. Fat thickness or outside fat, which affects cutability of a carcass, is closely related to live weight. If live weight is known, more than 50% of the variation in fat thickness and cutability score and slightly less than 50% of variation in quality grade can be determined by visual appraisal (Lewis *et al.*, 1969).

Many workers agree that live weight is positively correlated with fat thickness, percent kidney and pelvic fat, dressing percent, fat trim and l. dorsi area (Barton and Kirton, 1958; Bailey et al., 1961; Kirton and Barton, 1962; Kemp et al., 1969; Lambuth et al., 1970). As live weight increases, the percent total retail cuts, the percent total edible portion and the percent bone decreases (Lambuth, 1970). Ellsworth et al. (1966) found the same to be true of beef. Carpenter (1966) stated that some individuals prefer larger lambs to get larger cuts. Heavy lambs have been discriminated against because of the belief that consumers prefer young lambs and that heavy lambs are usually the older lambs (Weller et al., 1962).

Glimp et al. (1968) reported that as lambs become heavier more pounds of feed are required per pound of gain. They also found that it requires 5.50 pounds of feed per pound of gain from 40 pounds to 120 pounds or a total of 440 pounds per lamb. Most muscle development takes place prior to 100 pounds (Glimp et al., 1968). Deweese et al. (1969) agree that gains over 100 pounds are less efficient because the weight gain is fat which requires more feed per pound. However, a lamb may have the inherited ability to reach weights in excess of 100 pounds with minimum amount of fat and as efficiently as gains prior to 100 pounds (Whiteman et al., 1966).

Barton and Kirton (1958) and Kirton and Barton (1962) reported a high positive relationship between weight of the lamb and carcass fat when no selection was made for rate of gain. Latham et al. (1966) and Field, Kemp and Varney (1963) found nonsignificant correlations between carcass lean and rate of gain. Rate of gain increases from live weight of 40 pounds to 100 pounds and starts to decrease slightly thereafter (Kinsman, 1967; Glimp et al., 1968; Deweese et al., 1969). The relationship between rate of gain and amount of lean is affected basically by amount of fat put on after 100 pounds. Slow gaining lambs have more external fat, more kidney and pelvic fat, higher dressing percent and less lean than the more efficient, trimmer, faster gaining lambs (Whiteman, Walters and Munson, 1966; Kinsman, 1967, Lambuth et al., 1968; Deweese et al., 1969; Glimp et al., 1969; Lambuth et al., 1970).

Whiteman et al. (1966) reported correlations of -.22, 0.33 and -.18 between rate of gain at 10 weeks and percent ether extract of the carcass, percent lean tissue and percent bone, respectively. Rate of gain had a greater effect on fat covering than it did on the percent retail cuts or percent edible portion (Whiteman et al., 1966; Glimp et al., 1968; Lambuth et al., 1970).

Breed may affect the quantity of lean meat produced. Southam and Field (1969) reported whiteface lambs had significantly more kidney fat than blackface lambs and a lower percent of retail cuts. Breed differences were found by Whiteman et al. (1966) who reported that blackface lambs outperformed whiteface lambs. The meat breeds tend to finish faster and have better carcasses than the range breeds (Boylan and Seale, 1965; Vesley and Peters, 1966).

Early maturing breeds such as the Southdown (Kammlade and Kammlade, 1955; Acker, 1964; Briggs, 1969) tend to mature at a lighter weight and larger, growthier breeds such as the Hampshire and Suffolk tend to mature at heavier weights. The later maturing, heavier breeds would appear to have more pounds of red meat.

It is reasonable to assume that as lambs become heavier they produce heavier carcasses. Carcass weight and those measures (internal fat weight, l. dorsi area and all measures of fat thickness) which reflect an increase in size and in carcass weight display a highly significant positive relationship with weights of primal cuts (Smith et al., 1969). It has been reported by Kemp et al. (1969) and Lambuth et al. (1970) that as carcass weight increases percent edible portion and percent bone decreases and percent fat increases. Carpenter et al. (1969) reported carcass weight was consistently high in its value as an indicator of yield of the weights of preferred cuts.

Latham et al. (1966) reported a significant correlation of 0.18 between carcass fat and carcass weight per day of age and a nonsignificant correlation of 0.15 between carcass bone and carcass weight per day of age. As age of lamb and carcass weight increase so does fat, with bone and lean increasing at a decreasing rate (Whiteman et al., 1966). Carcass development occurs until it contains about 16% bone, 54% lean and 30% fat. Bone growth remains relatively constant throughout the development. Bones tend to develop proportionately to the rest of the beef carcass (Butler et al., 1956) which indicates that as bone measurements increase the length of body, length of loin, and chilled carcass weight increase. Whiteman et al. (1966) found that fat deposition starts slowly but increases rapidly toward the end of carcass development. As carcass weight increases so does the fat thickness (Deweese et al., 1969).

It was reported by Lambuth _et al._ (1970) that as carcass weight increased retail leg and shoulder declined as a percent of carcass. There was no significant increase in percent of retail loin and rack, but wholesale cuts increased due to more fat over the loin and rack. Kemp _et al._ (1969) reported a decrease in percent of leg, shank and kidney, but the percent of breast, flank and kidney fat increased as carcass weight increased. With an increase in carcass weight, the percent retail cuts decreased owing to extra fat trim in heavier carcasses. Kemp _et al._ (1969) found percent edible portion and bone decreased and percent fat increased as carcass weight increased. Whiteman _et al._ (1966) reasoned that this decrease in percent edible portion and percent bone was due to the increase in the percent of fat trim.

Southam and Field (1969) reported that as carcass weight increased there was an increase in the percent of kidney fat, fat depth over the _l. dorsi_ muscle and body wall thickness. As a result of increase in fat, there was a decrease in the estimated percent retail cuts as carcass weight increased. When comparing 46 to 55 pound carcasses to 56 to 65 pound carcasses, there was only a 1% decrease in retail cuts. They found considerable variation in fat thickness in all weight groups studied.

Carcass weight accounted for 46% and 31% of the variation in _l. dorsi_ area and dressing percent, respectively, and less than 10% for other traits studied according to Boylan and Seale (1965).

The effect of sex on lamb carcasses is quite small; however, Southam and Field (1969) reported that ewe carcasses were significantly fatter than wether carcasses. According to Boylan and Seale (1965) ewe carcasses had a higher percent of shoulder and loin and a higher dressing percent than wether carcasses. Ray and Mandigo (1963) found that ewe carcasses were fatter than ram carcasses and had a higher dressing percent. Ram carcasses were trimmer than wethers and wethers were trimmer than ewe carcasses. Rams had a lower dressing percent than wethers because of testicle weight while ewes had the highest dressing percent (Kemp et al., 1969).

L. dorsi area was larger for rams than for wethers, and wethers had larger l. dorsi muscle than did ewes (Field et al., 1963; Spurlock and Bradford, 1965; Judge et al., 1966; Kinsman, 1967). Ray and Mandigo (1966) found no differences in l. dorsi area of ram and ewe lamb carcasses but found pronounced differences of all other traits. Other workers (Walker, 1950; Kemp et al., 1962) reported ewes had the most fat trim, fat thickness and kidney fat. Carcasses of wether lambs had a higher dressing percent, more fat on the legs, lower retail cuts and less edible portion than ram lambs (Kemp et al., 1969). They also found that ram lambs had more carcass weight per day of age than wether lambs.

Knight and Foote (1965) and Judge et al. (1966) found that wether carcasses had a higher cutability than ewe carcasses. However, Field et al. (1963), Boylan and Seale (1965) and Oliver et al. (1967) do not completely agree as they found little differences in cutability. Carpenter et al. (1969) stated that this may be due to the inadequacy of the cutting procedures in providing uniform retail cuts as it is difficult to uniformly trim excessively fat carcasses. Carpenter et al. (1969) stated that data, within limits of the study, indicate that discrimination against ram carcasses when compared to wether carcasses is not justifiable on the basis of grade and cutability.

Conformation grade was more accurate than l. dorsi area as a measure of carcass desirability for the ram lamb carcasses (Carpenter et al., 1969). However, they suggested that conformation evaluation was in error as an estimate of muscling in ewe and wether carcasses because of greater subcutaneous fat covering.

Type of birth and rearing did not seem to affect carcass composition of twin and singles slaughtered at the same weight (Whiteman et al., 1966).

Whiteman et al. (1966) found that as a lamb becomes older the percent of fat increases and lean and bone decreases. They also reported that muscular lambs can be as fat or as lean as nonmuscular lambs depending upon length of feeding which is related to age. Ray and Mandigo (1963) found that as lambs become older l. dorsi area and bone increase but overall lean decreased.

Generally, it has been found with other species that tenderness of meat decreases with chronological age (Webb, 1960). Batcher et al. (1962) found this to be true for rib and loin cuts but not for leg cuts. Both Batcher et al. (1962) and Weller et al. (1962) found that tenderness did not change significantly with age and the flavor of roasts from older lambs scored milder than from younger lambs. Oliver et al. (1967) found that tenderness was significantly correlated with physiological age as evaluated by U.S.D.A. maturity scores but not significantly correlated with either marbling scores or extractable fat. A 1% increase in fat deposition of intramuscular fat for each 22 pounds of carcass did not seem to affect flavor and tenderness in lamb carcasses according to Vesley and Peters (1966).

The amount of internal and external fat affects the cutability of lamb carcasses (Barton and Kirton, 1958; Kirton and Barton, 1962; Field, Kemp and Varney, 1963; Ray and Mandigo, 1963; Latham, Moody and Kemp, 1966; Whiteman et al., 1966; Glimp et al., 1968; Lambuth et al., 1968; Carpenter et al., 1969; Kemp et al., 1969; Southam and Field, 1969; Lambuth et al., 1970) and beef carcasses (Ellsworth et al., 1966).

Many different indices have been devised to indicate this cutability in one form or another (Botkin et al., 1961; Hoke, 1961; Hiner and Thornton, 1962; Field, Kemp and Varney, 1963; Judge and Martin, 1963; Carpenter et al., 1964; Smith and Galgan, 1964; Carpenter, 1966; Spurlock, Bradford and Wheat, 1966; Johnston et al., 1967; Oliver, 1967; Field and Riley, 1968; Carpenter et al., 1969). The U.S.D.A. (1969) has incorporated subjective estimates of fatness into a yield grading system.

Some equations utilize, in addition to fat, other items such as conformation grade, percent untrimmed leg, chilled carcass weight, body wall thickness and/or leg and loin weight to predict trimmed retail cuts, percent lean in the carcass, percent edible portion, percent of boneless cuts or semi-boneless cuts. All of these indices are predicting the amount of trimmed retail cuts and their relation to edible portion.

Hoke (1961) indicated that variation in yield of major retail cuts of lamb carcasses was largely attributed to the amount of fat and bone which was removed in preparing the cuts. The reports of Hankins and Titus (1939), Knight, Foote and Bennett (1959), Field _et al._ (1963), Carpenter _et al._ (1964) and Oliver _et al._ (1967) suggest that inadequate trimming or differences in fat trimming procedures of the loin and rack may bias prediction equations in favor of fatter carcasses. Lambs which do not possess a fat covering equal to a predesigned standard (0.95 cm. - Hoke, 1961; 0.60 cm. - Judge _et al._, 1966; 0.64 cm. - Johnston _et al._, 1967) may be penalized whenever weight of primal cuts is the desired end point of carcass analysis. Therefore, a more thorough removal of fat should be included in the cutting procedures.

It has been reported by Barton and Kirton (1958), Kirton and Barton (1962), Field, Kemp and Varney (1963), Ray and Mandigo (1963), Latham, Kemp and Moody (1966), Whiteman, Walters and Munson (1966), Glimp _et al._ (1968), Lambuth _et al._ (1968), Carpenter _et al._ (1969), Kemp _et al._ (1969), Smith _et al._ (1969), Southam and Field (1969) and Lambuth _et al._ (1970) that internal fat deposition and fat thickness accounted for a greater variation in cutability than did muscling traits (leg conformation, body conformation and _l. dorsi_ area). Spurlock _et al._ (1966) noted that conformation scoring systems which rewarded blockiness inadvertently result in selection for animals with excess fat. Leg conformation has been reported by Spurlock _et al._ (1966), Johnston _et al._ (1967) and Field and Riley (1968) to be unreliable as a muscling index and contribute very little to the accuracy of equations for estimating lamb carcass composition. The U.S.D.A. yield grade system employs leg conformation as a predictor of muscling (U.S.D.A., 1969).

Oliver _et al._ (1968) and Smith _et al._ (1969) support the conclusion that any equation including carcass weight and some measurement of fatness will very accurately predict the weight of trimmed cuts. However, both reported that fat thickness was much more important than carcass weight, estimated percent internal fat and _l. dorsi_ area in explaining the variation in lean primal cut percentages. Johnston _et al._ (1967) and Smith _et al._ (1969) agreed that deposition of internal fat is of greater importance in equations predicting percent of trimmed primal cuts than in those predicting weight of trimmed primal cuts. Both fat scores and estimated internal fat scores have been successfully used as cutability indices according to Johnston _et al._ (1967).

Data collected by Carpenter _et al._ (1969) suggest greater accuracy may be obtained by the use of weights rather than ratios for the estimation of carcass desirability. When the final estimates are obtained, the value may be converted to a figure based upon ratio to actual carcass weight.

Callow (1948), Wilford and Garrigus (1952), Carpenter et al. (1964) and Smith et al. (1969) recognized that amount and distribution of fat is the major variable influencing lamb carcass composition. Fat trim has an inverse relationship to bone and edible portion (Kemp et al., 1969). Fat thickness at the 12th rib is the most informative single measurement for estimation of cutability (Carpenter, 1966). He also stated that by measuring kidney fat the estimation of yield of retail cuts is further improved. However, a large variation in percent kidney fat was found among carcasses.

Barton and Kirton (1958) found that the amount of separable fat in the carcass was highly correlated with carcass weight of mature sheep but somewhat lower when considering very lightweight lamb carcasses. Many workers (Callow, 1948; Hoke, 1961; Kirton and Barton, 1962; Judge and Martin, 1963; Stanley et al., 1963; Carpenter et al., 1964) have concluded that major changes in conformation of carcasses and in the chemical composition of their tissues depend largely upon the level of fatness of the carcass. Lean and bone components of the carcasses remain relatively constant, but differences in fat caused the major variation among tissues.

Carpenter (1966) reported that conformation and quality blend into a final grade with little regard to the quantity of waste fat or the yield of edible meat from the high priced cuts. He stated that generally higher grading carcasses yield lower percent retail cuts or percent lean primal cuts (Callow, 1948; Hoke, 1961; Spurlock and Bradford, 1965; Carpenter, 1966; Botkin, Schoonover and Field, 1967; Oliver et al., 1967). However, Hoke (1961) reported that higher conformation scores were associated with higher yields of retail cuts but also reported the correlation coefficients were significant only in the lower grades. The apparent greater influence of conformation score in the lower grades may be attributed to a narrower range of fatness than occurred in the higher grades. Smith et al. (1969) reported that quality scores and final grade were significantly related to retail rack weight. This suggests that either seam fat deposits contributed strongly to trimmed rack weight or that the cutting procedure they used favored heavy lambs, which usually grade higher. Lambuth et al. (1970) noted that carcass grade fluctuated over a normal range but as slaughter weight increased so did carcass grade. Also, flank streaking, feathering and fullness and firmness of flank increased as lambs fattened. However, as rate of gain increased, carcass grade decreased since the faster gaining lambs put on less fat. It has been stated by Southam and Field (1969) that prime lambs were fatter than choice and an increase in fatness results in an increase in grade.

Low relationships between l. dorsi area and retail yield have been reported by Stanley, Botkin and Schoonover (1960), Zinn (1961) and Carpenter et al. (1964). However, Judge et al. (1963), Carpenter et al. (1964) and Field and Riley (1968) reported l. dorsi area was a fairly accurate measure of muscling in carcasses within a narrow weight range but added little if reliable estimates of fat thickness were available. According to Smith et al. (1969), l. dorsi area contributes little to predictive accuracy of estimating retail cuts but concluded that since the muscle is easy to measure after a carcass has been ribbed its measurement can be justified for cutability approximation. Greater predictive accuracy has usually been achieved by adjusting l. dorsi area to reflect differences in carcass size or weight (Orme et al., 1962; Field et al., 1963; Judge et al., 1963; Carpenter et al., 1964; Spurlock and Bradford, 1965).

Eating quality has been defined by Batcher et al. (1962), Weller et al. (1962) and Carpenter et al. (1966) to be eating satisfaction or palatability. Carpenter (1966) stated that eating quality is estimated by appraisal of carcass factors which are assumed to be related to the eating desirabilities of lamb. He suggested that eating qualities be evaluated by tenderness, juiciness and flavor of the cooked meat. The evaluation of cooked meat decreases at each processing point along the line from the dinner plate to the live animal (Carpenter, 1966). There have been fewer studies relating to quality than to cutability.

The quality of cooked lamb was related to the fatness of the animal according to Batcher et al. (1962); however, intramuscular fatness did not affect tenderness, juiciness or flavor of the meat. Cover et al. (1944) reported that fatness was not related to tenderness.

Most studies have indicated low associations of quality characteristics with various palatability factors (Stouffer *et al.*, 1958; Weller *et al.*, 1962; Carpenter *et al.*, 1964; Carpenter and King, 1965a,b). The study reported by the American Sheep Producers Council (A.S.P.C., 1964) also yielded some information regarding quality characteristics of lamb. In two separate trials they reported the consumer preferred the lower grades (good and utility) of leg and loin chops and, when given a choice between two grades at the same price, they picked the lower grade. In this study a significant preference was shown for choice over prime grades of lamb cuts, while there was no difference between preference for good and choice. Carpenter (1966) reported that chronological maturity appears to be associated with quality in terms of tenderness and color.

Carpenter (1966) concluded that current lamb carcass grades furnish little more than a common language for rather broad groups of carcasses that are quite variable in cutability, quality and consumer preference. He also estimated that less than 10% of the current choice and prime carcasses will yield 70% preferred retail cuts from shoulder, rack, loin and leg.

The A.S.P.C. (1964) report stated that leanness is an extremely important characteristic used by consumers when purchasing lamb. The Industrywide Lamb and Wool Planning Committee (1964) defines "Consumer Preferred Lamb" as a 94 to 105 pound lamb, grading average choice and having three square inches of *l. dorsi* area per 50 pounds of carcass. The leg should be wide, deep and heavily muscled. There should be 70% of the carcass in trimmed retail cuts. The fat covering should range between 0.2 and 0.3 of an inch. Little information is available regarding the minimum fat covering needed on lamb carcasses in order to assure the desired product after movement through the various marketing channels. A fat covering of at least 0.5 cm. is probably needed to prevent product dehydration and to produce an attractive retail cut in the meat counter (Carpenter, 1966).

According to Carpenter (1966), if lamb carcasses contained the meatiness or cutability we have set forth, problems in lamb merchandising would be substantially reduced. Carpenter stated that the suggested goal for l. dorsi area may be difficult to obtain. He also estimated only 3% of lambs currently produced would meet this requirement. It is apparent that l. dorsi area is important for consumer purchasing decisions. Although reports of Field et al. (1963), Carpenter et al. (1964) and Carpenter and King (1965b) indicate that l. dorsi area is not closely associated with the yield of retail cuts, edible meat or boneless portion, it is of great importance when considering consumer preference. Research is not available to confirm this theory of the importance of the size of the l. dorsi muscle in lamb carcasses.

A fat probe over the center of the l. dorsi muscle can be obtained with minimal physical changes in the intact carcass and its relationship to percent retail primal cuts ($r = 0.85$) is very nearly the same as that (r = 0.86) for total fat measure (Field and Riley, 1968; Smith et al., 1969).

Field et al. (1963) suggested that methods should be developed for quick and accurate estimation of the composition of lamb carcasses. Prediction equations are available which involve little change in the integrity of the carcass, most of which require only the removal of internal fat deposits and exposure of the 12th rib interface (Hoke, 1961; Judge et al., 1963; Spurlock and Bradford, 1965; Judge et al., 1966; Johnston et al., 1967; Field and Riley, 1968; Oliver et al., 1968; Carpenter et al., 1969). It can generally be stated that the more individual measurements of fat thickness incorporated into an average fat measure, the more accurate the equation will be for predicting trimmed primal cut weight. Measures of fat thickness are of great relative importance in predicting the weight of trimmed cuts obtained from a carcass (Smith et al., 1969). Strong negative relationships between carcass yield and fat depth measures taken opposite the l. dorsi muscle were found by many workers (Hoke, 1961; Zinn, 1961; Hiner and Thornton, 1962; Judge and Martin, 1963; Field et al., 1963; Spurlock and Bradford, 1965; Judge et al., 1966; Oliver et al., 1967; Smith et al., 1969).

A "body wall thickness" measurement as an indicator of carcass fatness has been used in equations by Carpenter et al. (1964), Judge et al. (1966), Oliver et al. (1967), Field and Riley (1968) and Oliver et al. (1968). However, the inclusion of this measurement failed to affect the magnitude of the correlation coefficient between measures of carcass fatness and percent lean primal cuts.

In a study of Rocky Mountain lambs by Southam and Field (1969), they considered lambs under 2 mm. (0.1 in.) of fat underfinished and lambs having over 7 mm. (0.3 in.) to be overfinished. Data were collected on every 10th or 20th carcass hanging in the coolers on a given day. They found that 10.6% were underfinished, 79.5% properly finished and 9.9% were overfinished. Eighty-two percent of the overfinished lamb carcasses weighed over 55 pounds; however, 82.7% of those carcasses weighing from 55 pounds to 66 pounds had between 4 mm. (0.12 in.) and 7 mm. (0.3 in.) of fat. They concluded that the majority of Rocky Mountain lamb carcasses are over 55 pounds but are not overfinished.

In a consumer selection study, Southam and Field (1969) found that size of the muscle was a criteria for selection and cuts from heavier carcasses were selected over the cuts from lighter carcasses ($P<.01$). All packages were the same weight and had the same amount of external fat. When leg roasts of various weights were sold whole, the smaller legs were chosen. However, when sirloin chops were cut from the ends of the larger legs making them approximately the same weight and having the same external fat as the smaller legs, no significant differences were found. However, when comparing sirloin chops and leg roasts from heavy and lightweight carcasses in a random finish selection trial, consumer selection favored the lighter carcasses ($P < .01$). The degree of finish was a determining factor in the selection.

The researchers concluded that it seems more reasonable to suggest that retailers process heavier, correctly finished carcasses. Per unit of cost, they would benefit more from the increased weight of salable cuts from heavier carcasses than those they now prefer. These larger cuts would be selected equally or more readily than the lighter cuts (Southam and Field, 1969). Correct cutting procedures must be followed. Field and Riley (1968) believed packers and retailers could benefit from lower costs per unit of weight and also from slightly higher dressing percents from the heavier lambs. They also concluded that price discrimination against heavy lambs should be eliminated.

The following are three experiments conducted on the effect of slaughter weight on carcass composition.

Lambuth et al. (1970) placed 72 lambs in a 2 x 3 factorial arrangement of fast and slow gaining groups and slaughtered in three groups at 36, 45, and 54 kg., respectively, to study the effect of average daily gain and slaughter weight on carcass composition. No significant difference in total retail yield or edible portion was found, but the faster gaining lambs had a lower percent total fat trim and higher percent total bone than the slow gaining lambs. The heavier slaughter weight lambs had a higher percent total fat trim and a lower percent total retail yield, edible portion and bone than the lighter slaughter weight groups.

Flavor and tenderness are two factors that affect consumer demand for lamb (Weller _et al._, 1962). These factors were studied in an experiment involving 60 Columbia, twin, wether lambs which were divided into six groups at weaning time (120 days) and fed a standard fattening ration. Three of the groups were slaughtered at 85, 110 and 135 pounds and the other three groups at 150, 200 and 245 days. One leg from each carcass was boned, rolled and held in frozen storage.

Tenderness by scores, "chews" and shear values appeared unrelated to weight or age of lamb. Cooking losses from the leg of lamb roasts did not vary.

Roasts from lambs older than six months were scored as milder in flavor than those from younger animals. There was a significant difference in the scores for flavor among the six groups. Analysis of variance for preference rank did not show a statistically significant difference. However, the youngest lambs (85 pounds and 150 days) were given fourth preference (least liked) the greatest number of times. Also, according to tabulations of descriptive terms, animals older than six months (over 100 pounds) were found more often to have a "natural" lamb flavor.

Kemp _et al._ (1969) placed 30 crossbred ram lambs and 30 crossbred wether lambs on feed in drylot at 18 kg. Lambs were assigned in equal numbers to slaughter weights of 36, 45 and 54 kg. They found the heavier lambs were fatter and had lower yields of retail cuts and edible portion and higher yields of fat trim. Dressing percent increased as weight increased due to the increase in fatness.

It is evident that from studies of physiological maturity and growth the means can be provided for production of heavier lambs that may be more economical for the entire industry. Perhaps edible meat per day of age is the most important trait for consideration when describing "industry preferred lamb." Carpenter (1966) and Southam and Field (1969) reported that less labor per pound of retail cuts was required for carcasses weighing 65 to 70 pounds than for carcasses weighing 45 to 50 pounds. It seems reasonable that the same amount of time and facilities is required to dress, chill and cut the light-weight lamb as it does the heavyweight lamb which yields more pounds of retail cuts.

METHODS OF PROCEDURE

Seventy-two lambs from approximately 130 pound whiteface ewes (predominantly Columbia-type breeding) and sired by 225 to 250 pound blackface rams (Hampshire or Suffolk) were used in this experiment. These February born lambs were creep fed, vaccinated against enterotoxemia when about 30 days old and weaned at about 60 days of age.

The lambs were randomly allotted according to weaning weight and sex into 12 groups (4 treatments and 3 replications) of 6 lambs each, 3 wethers and 3 ewes. The treatment feedlot weights at which the lambs were removed for slaughter were (1) 95 pounds, (2) 110 pounds, (3) 125 pounds and (4) 140 pounds.

The lambs were confined to about 12 square feet per lamb in a straw bedded building. A complete pelleted ration (table 1) was self-fed. All feed was weighed and recorded. Feed efficiencies were computed on a group basis. No treatment for external or internal parasites was administered during the course of the study.

The lambs were weighed every two weeks until they reached their respective treatment feedlot weight. Average daily gain was computed for all lambs. After removal from the lot, the lambs were sheared and transferred to the holding facilities at the South Dakota State University meat laboratory. In the holding facilities the lambs were subjected to a 24-hour shrink with access to water but no feed.

Before slaughter each lamb was weighed to the nearest pound. Immediately after weighing, the lamb was taken to the slaughter area, stunned, hung up and bled. After bleeding, the hide was removed and

TABLE 1. PELLETED RATION FED TO LAMBS

	Lb.
Alfalfa hay	600
Corn	700
Oats	460
Soybean oil meal	210
Trace mineral salt	20
Ground limestone	10
Aureofac 10 (added to 2000 lb. of mix)	1

the carcass was eviscerated according to procedures outlined by Ziegler (1963). The carcasses were washed with cold water and placed in the cooler.

After the carcasses were chilled for at least 48 hours at a temperature of 36 to 38° F., fat probes (figure 1) were taken 1 1/2 inches off the mid-line over the shoulder, rack, loin and leg regions. Carcass length (figure 2) was measured from the anterior portion of the first rib to the anterior portion of the aitch bone.

The carcasses (figure 3) were cut into wholesale cuts as outlined by Ziegler (1963), except the kidney, kidney fat and excessive pelvic fat were removed and weighed prior to breaking the carcass.

The carcasses were divided between the 12th and 13th rib and the fore and rear saddle were weighed. The kidney, kidney fat and excessive pelvic fat which were removed and weighed separately were included in the rear saddle weight. The fore and rear saddles were

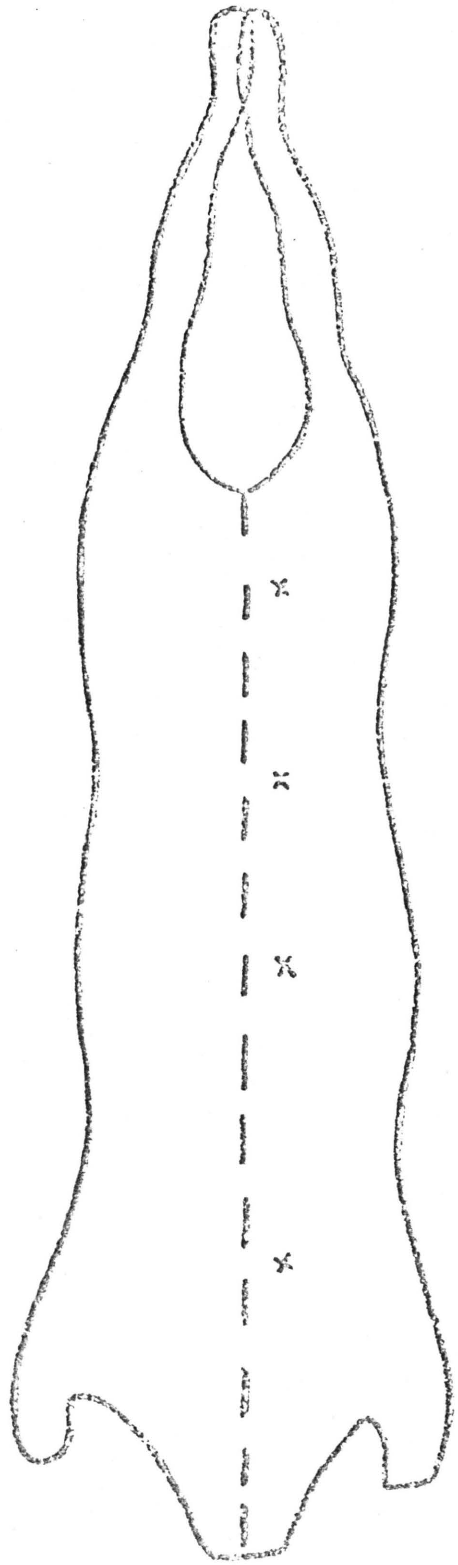


Figure 1. Fat thickness probes for shoulder, rack, loin and leg regions.

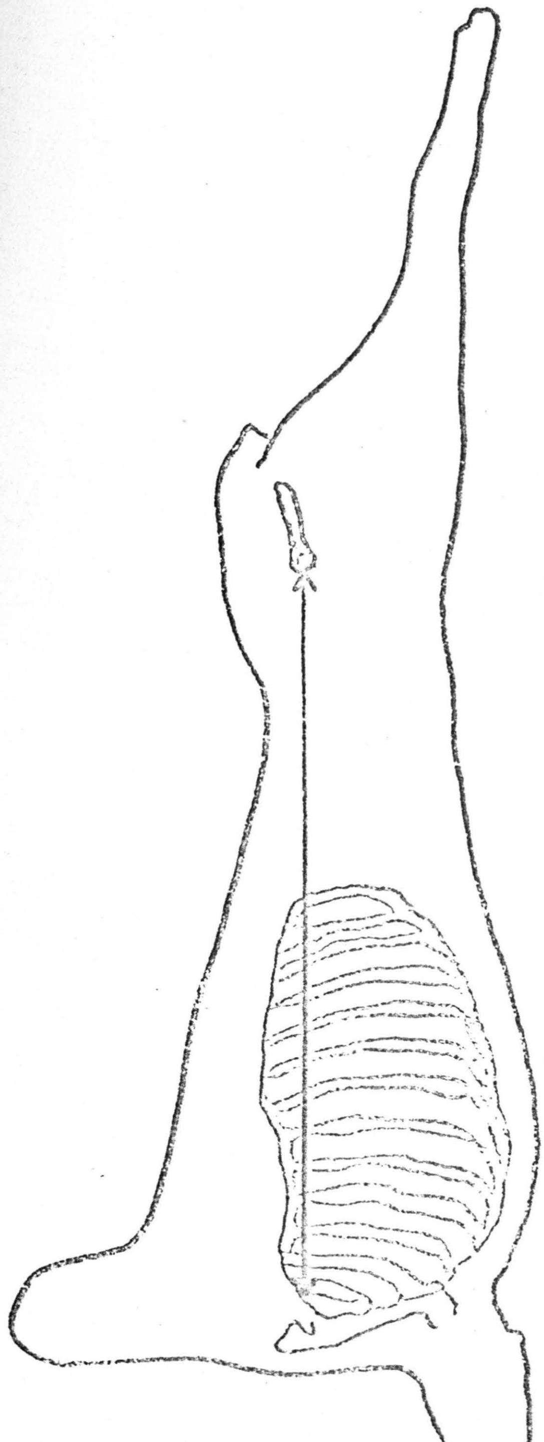
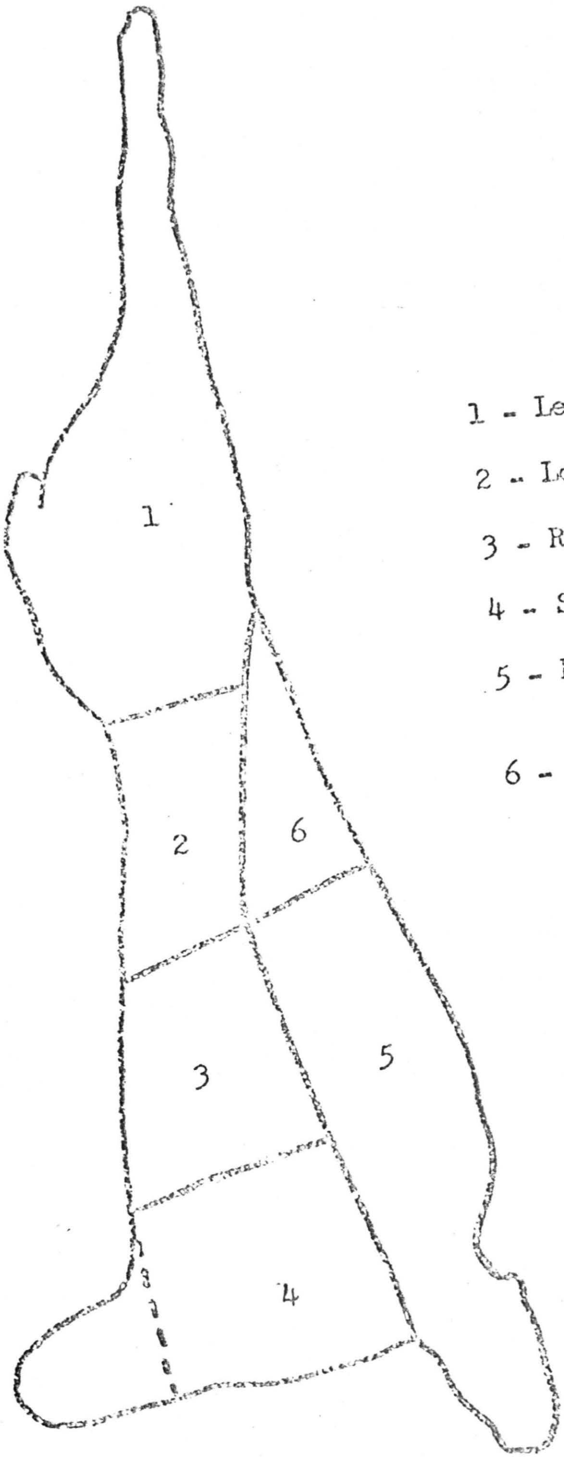


Figure 2. Carcass length: aitch bone to first rib.



1 - Leg

2 - Loin

3 - Rack

4 - Shoulder

5 - Breast and fore shanks

6 - Flank

Figure 3. Wholesale cuts.

divided into wholesale cuts as outlined by Ziegler (1963). Further processing involved the separation of each wholesale cut into edible portion, fat trim and bone components. Edible portion (E. P.) denotes the boneless roasts, which were trimmed to 0.1 inch external fat, and the lean trim, which contained about 18% fat.

In the boning process, excessive intermuscular fat deposits were removed and included in the fat trim of each individual cut. All weights were taken to the nearest 0.1 pound.

The individual wholesale cuts were handled in the following manner:

A. Shoulders

1. A band saw was used to remove the neck (included in wholesale weight) and to split the shoulders.
2. All excessive external fat (trimmed to 0.1 inch) and internal fat were removed to obtain a trimmed weight.
3. The weight of the edible portion included the boneless shoulder roasts and all lean trim from the shoulder.
4. The fat trim included all internal and external fat removed.
5. The bone weight was comprised of the scapula, upper portion of the humerus and the neck bones (first five ribs and thoracic vertebra and cervical vertebra).

B. Rack

1. The rack as removed from the carcass comprised the wholesale weight.

2. The rack was trimmed to 0.1 inch external fat and all excessive internal fat was removed before obtaining a trimmed rack weight.
3. The edible portion of the rack consisted of a boneless rack roast and the lean trim.
4. All internal and external fat removed in boning was included in the fat trim.
5. The bone weight included the seven thoracic vertebrae and the dorsal portion of seven ribs.

C. Loin

1. A tracing was made on acetate paper of the *longissimus dorsi* muscle and the fat covering. The area of the *l. dorsi* muscle was measured in square inches by the use of a compensating polar planimeter.
2. Fat thickness was an average of three measurements taken perpendicular to the *l. dorsi* muscle (figure 4). Measurement A was taken over each *l. dorsi* muscle three-fourths of the way from the median. Measurement B was taken over the rib at the thickest fat depth.
3. The wholesale weight was the whole loin as removed from the carcass.
4. The loin was trimmed to 0.1 inch of external fat. Excessive internal fat was removed and the trimmed loin weighed.

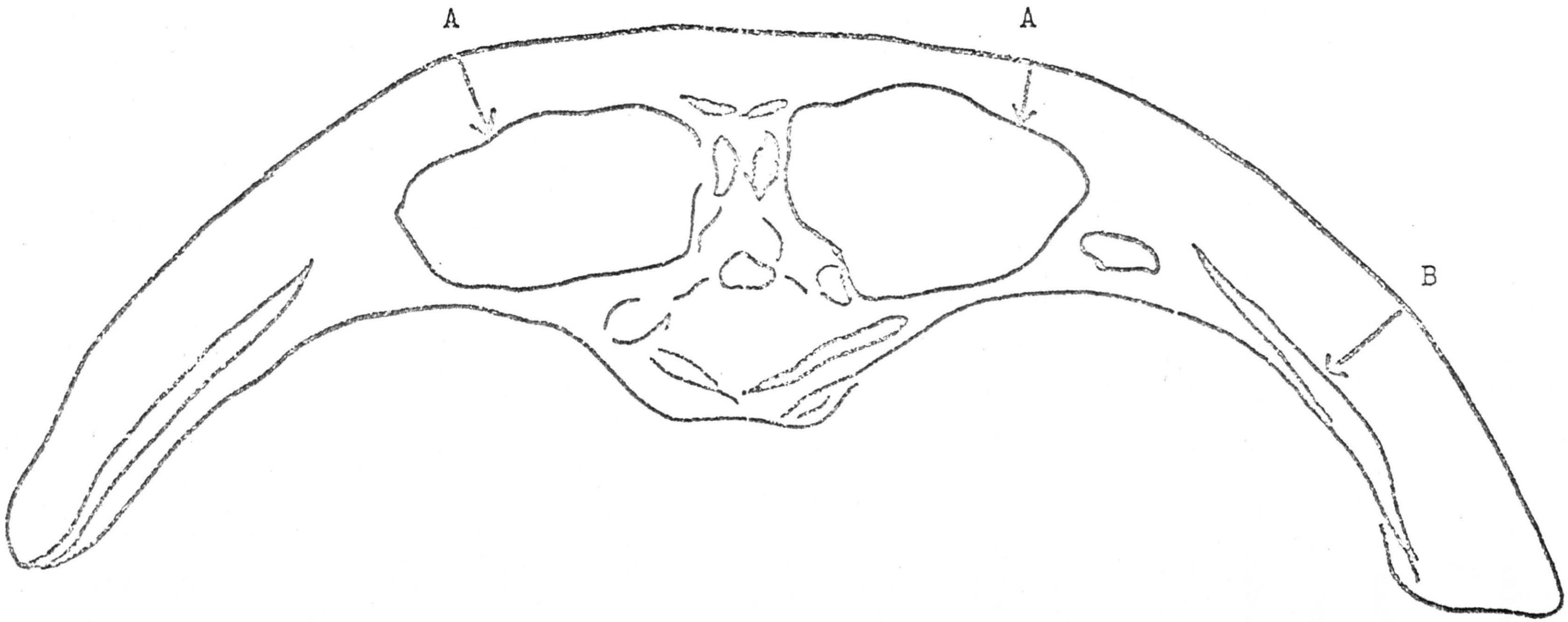


Figure 4. Fat thickness measurements.

5. The edible portion included the boneless loin roasts and all lean trim.

6. The fat trim included all external and excessive internal fat removed in the boning process.

7. The bone weight was comprised of seven lumbar vertebrae, the 13th thoracic vertebra and the 13th rib.

D. Legs

1. The rear shanks were included in the wholesale weight.

2. The legs were split by a band saw to enable easier boning.

3. The rear shanks were removed at the patella and boned.

4. The legs were trimmed to 0.1 inch of external fat and all excessive internal fat was removed before obtaining the trimmed weight.

5. The boneless leg roasts and all lean trim were combined to yield edible portion.

6. The fat trim included all internal and external fat removed in the boning process.

7. The bone weight of the legs included the pelvic girdle, femur, tibia-fibula and coccygeal sacral vertebra.

E. Breasts and Fore Shanks

1. The wholesale weight was comprised of the breast and fore shanks as removed from the carcass.

2. The cuts were boned to yield edible portion (all lean trim), fat trim and bone (the ulna-radius, metacarpals and carpals), the lower portion of the humerus and the ventral portion of the 13th ribs.

F. Flanks

1. The flanks were weighed as a wholesale cut after they were removed from the carcass.
2. The flanks were separated into edible portion (lean trim) and fat. No bone weight was taken as the single floating rib was included in fat trim.

All data were placed upon IBM cards and the analysis of variance obtained using the least squares method. Simple correlations were also computed.

RESULTS AND DISCUSSION

Live weight was the major variable in this experiment. Therefore, the effect of live weight on each weight, measurement or percentage will be discussed. Also, the influence of sex will be discussed. Means for each variable are listed in the appendix by weight group and sex.

The average feedlot weights for the four weight groups were 96, 109, 122 and 135 pounds, respectively. The overall mean for slaughter weight was 100 pounds with a standard deviation of 15 pounds.

Rate of daily gain (table 2) was not significantly influenced by live weight, sex or treatment x sex interaction. The average daily gain for the four weight groups was 0.48 pound per day with a standard deviation of 0.11 pound. The mean rates of gain for the 95, 110, 125 and 140 pound weight groups were 0.53, 0.50, 0.42 and 0.44 pound, respectively. The wether lambs gained 0.55 pound per day as compared to the ewe lambs which gained 0.44 pound per day. When the first lamb in the lightest weight group reached a weight of 95 pounds, the average rate of gain was approximately the same for all groups. As lambs increased in age or weight, rate of gain decreased.

Animal age (table 2) at slaughter, which varied from 133 to 238 days for the 95 and 140 pound weight groups, respectively, was significantly ($P < .01$) influenced by treatment. A larger difference in age was noted between the 110 and 125 pound weight groups than between the 95 and 110 pound groups or between the 125 and 140 pound groups. The wethers were 182 days and the ewes were 197 days old at slaughter time;

TABLE 2. ANALYSES OF VARIANCE FOR RATE OF DAILY GAIN AND ANIMAL AGE AT SLAUGHTER

Source	d.f.	Mean squares: Rate of daily gain	Mean squares: Animal age
Rep	2	0.002	1283.86
Treatment	3	0.046	39563.42**
Rep x treatment	6	0.015	691.40
Sex	1	0.059	3706.61
Rep x sex	2	0.010	866.54
Treatment x sex	3	0.016	543.83
Rep x treatment x sex	6	0.013	778.07
Error	45	0.010	708.93
Total	68		

** $P < .01$.

however, this difference was not significant. The age difference was not significantly influenced by the treatment x sex interaction.

The average amounts of feed consumed from weaning to slaughter per lamb for the 95, 110, 125 and 140 pound weight groups were 298, 400, 535 and 685 pounds, respectively. The average pounds of feed per pound of gain increased slightly with the 95, 110, 125 and 140 pound groups using 7.26, 7.55, 7.85 and 8.65 pounds, respectively.

The 95, 110, 125 and 140 pound groups required 11.5, 14.4, 17.3 and 20.9 pounds of feed per pound of edible portion. Feed efficiency was not statistically tested; however, it appears that after 95 pounds it takes approximately an additional 3 pounds of feed to produce 1 pound of edible portion for every 13 pound increase in body weight.

It was noted that at 95 pounds all groups required about the same amount of feed per pound of gain. As lambs increased in age or weight, the pounds of feed required per pound of gain increased.

Carcass Evaluation

Analyses of variance for fat probes and dressing percent are given in table 3. Fat thickness, carcass length and l. dorsi area analyses of variance are given in table 4. The average fat probes over the leg, loin, rack and shoulder regions were 0.43, 0.50, 0.56 and 0.45 inch, respectively. Standard deviations of 0.31, 0.44, 0.69 and 0.45 inch were found for the leg, loin, rack and shoulder regions.

The differences in weight or sex did not significantly affect the fat probes. However, wethers had a deeper probe over the leg, rack and shoulder (0.43, 0.58 and 0.46 inch, respectively) as compared to the ewes (0.35, 0.45 and 0.34 inch). The loin probe of ewes was 0.57 inch of fat with wethers having 0.47 inch. The average fat thickness for ewe lambs was 0.49 inch as compared to wether with 0.45 inch of fat at the 12th rib. This difference was not significant. The average fat thickness (0.46 inch with a standard deviation of 0.15) was significantly ($P < .01$) influenced by treatment. As expected, average fat thickness increased as live weight increased. The difference between the 95 and 110 pound groups was 0.07 inch. However, an increase of 0.15 inch was found between the 125 and 140 pound

TABLE 3. ANALYSES OF VARIANCE FOR FAT PROBES AND DRESSING PERCENT

		Mean squares				
Source	d.f.	Leg probe	Loin probe	Rack probe	Shoulder probe	Dressing percent
Rep	2	0.005	0.561	0.341	0.113	6.86
Treatment	3	0.045	0.074	0.449	0.131	71.26*
Rep x treatment	6	0.054	0.298	0.190	0.205	7.06
Sex	1	0.109	0.147	0.261	0.258	34.47
Rep x sex	2	0.041	0.379	0.211	0.131	0.28
Treatment x sex	3	0.054	0.690	1.186	0.348	14.67
Rep x treatment x sex	6	0.070	0.383	0.344	0.111	9.94
Error	45	0.088	0.475	0.332	0.153	10.34
Total	68					

* $P < .05$.

TABLE 4. ANALYSES OF VARIANCE FOR *L. DORSI* AREA, FAT THICKNESS AND CARCASS LENGTH

Source	d.f.	Mean squares *L. dorsi* area	d.f.	Mean squares Fat thickness	d.f.	Mean squares Carcass length
Rep	2	0.049	2	0.008	2	8.701
Treatment	3	0.431**	3	0.138**	3	14.748
Rep x treatment	6	0.058	6	0.014	6	0.960
Sex	1	0.056	1	0.030	1	0.154
Rep x sex	2	0.063	2	0.005	2	5.667
Treatment x sex	3	0.091	3	0.004	3	4.405
Rep x treatment x sex	6	0.060	6	0.010	6	4.539
Error	40	0.044	39	0.017	36	4.086
Total	63		62		59	

** $P < .01$.

groups with the 110 and 125 pound groups having the same average fat thickness (0.45 inch).

Dressing percent was significantly ($P < .05$) influenced by weight groups only. The average dressing percent was 46.9% with a standard deviation of 3.51%. The means were 44.4, 45.8, 48.2 and 48.8% for the 95, 110, 125 and 140 pound groups, respectively. A large increase in dressing percent was noted between the 110 and 125 pound groups, indicating a change in body composition. Wether lambs had a slightly lower dressing percent than did ewe lambs (46.0 and 47.5%, respectively). This suggests the wether lambs were trimmer and agrees with the work of Southam and Field (1969), Boylan and Seale (1965), Ray and Mandigo (1963) and Kemp _et al_. (1969).

Carcass length was studied and no significant differences were found. The mean carcass length was 24.6 inches with a standard deviation of 2.0 inches. Wether lambs measured 24.7 inches and the ewes measured 24.6 inches.

Average _l. dorsi_ area was significantly ($P < .01$) influenced by treatment and increased as live weight increased. The average _l. dorsi_ area was 1.93 square inches with a standard deviation of 0.27 square inch. The 95, 110, 125 and 140 pound groups exhibited 1.78, 1.83, 1.99 and 2.14 square inches, respectively. No significant differences were observed between wether and ewe carcasses.

Chilled carcass weight is very important to the packer at the present time because this is what he sells to the wholesaler or "jobber." The analyses of variance for carcass weight, fore saddle weight, rear saddle weight and percent kidney fat are shown in table 5. The average chilled carcass weight was 54.3 pounds with a standard deviation of 10.2 pounds. The means were 42.8, 50.0, 58.9 and 66.0 pounds for the 95, 110, 125 and 140 pound groups. As would be expected, a significant treatment difference ($P < .01$) was noted for chilled carcass weight. No significant difference in chilled carcass weight was found between wethers and ewes (54.3 and 54.6 pound carcasses, respectively). Significant differences ($P < .01$) due to treatment for fore and rear saddle weights were shown. The means for fore saddle weight were 21.6, 25.0, 28.5 and 32.3 pounds for the 95, 110, 125 and 140 pound groups, respectively. The means for rear saddle weights were 21.5, 25.4, 30.4 and 34.2 pounds for the 95, 110, 125 and 140 pound groups, respectively. The overall mean for the fore saddle weights was 26.8 pounds and 27.9 pounds for the rear saddle. Fore and rear saddle weights had comparable increases. However, between the 110 pound and the 125 pound group an increase of 5.0 pounds was noted for the rear saddle weight and only 3.5 pounds for the fore saddle. Sex or the treatment x sex interaction did not significantly affect the weight of the fore or the rear saddle.

The percent of kidney fat plays an important role in dressing percent and percent of trimmed retail cuts. The average kidney fat percent was 3.9% with a standard deviation of 1.5%. The average means were 3.1, 3.4, 4.1 and 4.6% for the 95, 110, 125 and 140 pound groups. Percent kidney fat was significantly ($P < .05$) affected by treatment

TABLE 5. ANALYSES OF VARIANCE FOR CHILLED CARCASS WEIGHT, FORE SADDLE WEIGHT, REAR SADDLE WEIGHT AND PERCENT KIDNEY FAT

		Mean squares			
Source	d.f.	Carcass weight	Fore saddle weight	Rear saddle weight	Percent kidney fat
Rep	2	6.32	0.10	4.60	1.83
Treatment	3	1769.29**	357.54**	531.39**	8.26*
Rep x treatment	6	23.76	4.36	8.92	4.24
Sex	1	1.64	0.44	3.67	7.98
Rep x sex	2	9.76	1.98	3.03	0.06
Treatment x sex	3	41.65	11.04	11.50	2.19
Rep x treatment x sex	6	23.73	6.26	6.52	1.46
Error	45	29.02	7.64	9.20	1.43
Total	68				

* $P < .05$.
** $P < .01$.

but was nonsignificantly influenced by sex or the treatment x sex interaction.

The wholesaler or "jobber" is interested in the amount or the percent of wholesale cuts he can obtain from a carcass. The analyses of variance for all wholesale cuts are given in table 6. Total pounds of wholesale cuts were significantly ($P < .01$) influenced by treatment. The overall mean for all four weight groups was 52.4 pounds with a standard deviation of 9.3 pounds. As live weight increased, so did total wholesale weight. The 95, 110, 125 and 140 pound groups averaged 41.8, 48.7, 56.5 and 63.2 pounds, respectively. Ewes did not differ significantly from wethers (52.5 and 52.6 pounds, respectively) and no significant difference was shown for the treatment x sex interaction.

Significant weight differences ($P < .01$) were noted for wholesale leg, loin, rack, shoulder and flank. However, no significant difference was found for the breast and fore shank weight. The means for wholesale leg, loin, rack and shoulder of each weight group are shown in table 7. Sex or treatment x sex interaction did not significantly influence any of the wholesale weights.

Wethers had larger legs (17.0 vs. 16.5 pounds) and breast and fore shanks (7.9 vs. 7.5 pounds), but ewes had larger flanks (3.0 vs. 2.7 pounds), racks (6.4 vs. 6.0 pounds) and loins (6.2 vs. 6.0 pounds). Shoulders from wethers and ewes were the same weight (12.9 pounds).

The amount or the percent of trimmed primal retail cuts (leg, loin, rack and shoulder) is important to the retailer. His profit

TABLE 6. ANALYSES OF VARIANCE FOR ALL WHOLESALE CUTS AND TOTAL WHOLESALE WEIGHT

		Mean squares						
Source	d.f.	Wholesale leg	Wholesale loin	Wholesale rack	Wholesale shoulder	Wholesale flank	Wholesale breast and fore shank	Total wholesale weight
Rep	2	0.82	0.14	0.27	1.62	0.72	0.19	2.34
Treatment	3	122.11**	27.16**	54.46**	129.81**	13.70**	1.80	1497.21**
Rep x treatment	6	2.19	0.38	0.57	1.87	0.66	2.45	19.68
Sex	1	3.28	0.23	1.94	0.06	2.18	3.30	0.27
Rep x sex	2	2.16	0.28	2.00	2.04	0.36	0.74	9.59
Treatment x sex	3	1.06	0.98	3.65	7.48	1.96	1.90	29.51
Rep x treatment x sex	6	3.64	0.52	1.08	2.11	0.40	1.28	22.99
Error	45	2.09	1.39	1.40	2.83	0.58	2.86	23.22
Total	68							

** $P < .01$.

TABLE 7. OVERALL MEANS, STANDARD DEVIATIONS AND TREATMENT MEANS FOR WHOLESALE CUTS

Wholesale cut	Mean	S.D.	Mean/group (1-4)
Leg	16.6	2.7	13.6
			15.7
			17.9
			19.8
Loin	6.2	1.5	4.7
			5.5
			6.5
			7.6
Rack	6.2	2.0	4.4
			5.4
			6.5
			8.5
Shoulder	12.9	2.7	9.8
			11.6
			14.2
			16.0
Breast and fore shanks	Not computed		7.3
			8.1
			7.8
			7.6
Flank	Not computed		1.8
			2.4
			3.6
			3.6

depends upon how much trimming is needed on each wholesale cut. The analyses of variance for trimmed retail cuts, trimmed leg, trimmed loin, percent trimmed leg, percent trimmed loin and percent trimmed leg and loin are found in table 8. Treatment significantly ($P < .01$) influenced total pounds of trimmed primal cuts. The means were 27.0, 30.8, 34.3 and 36.2 pounds for the 95, 110, 125 and 140 pound groups, respectively. The average total pounds of trimmed primal cuts was 32.0 pounds with a standard deviation of 4.7 pounds. The percent of trimmed primal retail cuts was significantly ($P < .01$) influenced by treatment. The average percent trimmed primal retail cuts was 59.5% with a standard deviation of 4.6%. The mean percentages of trimmed retail cuts for the 95, 110, 125 and 140 pound groups were 62.6, 61.2, 58.3 and 55.6%, respectively. The percent of trimmed primal retail cuts decreases as live weight increases. However, more pounds of trimmed primal retail cuts from each carcass are obtained as live weight increases. No significant difference was found between wethers and ewes or from the treatment x sex interaction.

In the swine industry considerable emphasis is placed on the pounds or percent of trimmed ham and loin obtained from the animal. The pounds or percent of trimmed leg and the pounds or percent of trimmed loin were studied. Trimmed leg weight was significantly ($P < .01$) influenced by treatment. The overall mean trimmed leg weight was 13.6 pounds with a standard deviation of 1.8 pounds. The 95, 110, 125 and 140 pound weight groups averaged 12.0, 13.5, 14.5 and 15.0 pounds, respectively. No difference was shown between wethers and

TABLE 8. ANALYSES OF VARIANCE FOR TRIMMED RETAIL CUTS, TRIMMED LEG, TRIMMED LOIN, PERCENT TRIMMED LEG, PERCENT TRIMMED LOIN, PERCENT TRIMMED LEG AND LOIN AND PERCENT TRIMMED PRIMAL CUTS

		Mean squares						
Source	d.f.	Trimmed retail cuts	Trimmed leg	Trimmed loin	Percent trimmed leg	Percent trimmed loin	Percent trimmed leg and loin	Percent trimmed primal cuts
Rep	2	4.30	4.18	0.37	0.75	0.11	0.88	10.75
Treatment	3	286.55**	30.52**	1.88	12.06*	1.74	7.52	166.57**
Rep x treatment	6	3.86	1.60	0.37	2.48	0.34	2.40	7.13
Sex	1	9.17	0.58	0.14	7.50	1.23	2.60	20.30
Rep x sex	2	5.49	0.24	0.20	0.74	1.06	3.36	10.16
Treatment x sex	3	25.31	4.74	0.51	1.43	4.18	6.07	7.77
Rep x treatment x sex	6	6.01	3.67	1.01	1.98	1.38	1.94	7.17
Error	45	10.42	1.96	0.78	2.09	3.24	5.02	16.42
Total	68							

* $P < .05$.
** $P < .01$.

ewes. The treatment x sex interaction did not significantly affect trimmed leg weight.

The trimmed loin weight was not significantly affected by treatment. The overall mean was 4.1 pounds with a standard deviation of 0.9 pound. Means of 3.6, 3.9, 4.4 and 4.2 pounds were shown for the 95, 110, 125 and 140 pound groups. Sex did not significantly influence trimmed loin weight (4.1 and 4.0 pounds for wethers and ewes, respectively). The treatment x sex interaction showed no significant difference.

The percent of leg and loin of the carcass was not significantly affected by treatment, sex or treatment x sex interaction; however, a significant difference ($P < .05$) was shown for the percent leg due to treatment. The means for percent leg were 31.9, 31.4, 30.4 and 30.0% for the 95, 110, 125 and 140 pound groups, respectively. The overall mean for percent leg and loin was 42.1% with a standard deviation of 2.1%. The 95, 110, 125 and 140 pound groups had means of 42.9, 42.5, 41.4 and 41.7%, respectively. Therefore, as live weight increases, the percent leg and loin decrease but this decrease is not significant.

The analyses of variance for pounds of boneless roasts and for percent boneless roasts are shown in table 9. The average amount of boneless roasts from each carcass in the 95, 110, 125 and 140 pound groups were 16.3, 17.9, 20.2 and 21.8 pounds, respectively. The overall mean was 18.8 pounds with a standard deviation of 2.8 pounds. Wether lambs had 19.3 pounds and ewe lambs had 18.8 pounds of boneless

TABLE 9. ANALYSES OF VARIANCE FOR POUNDS OF BONELESS ROASTS AND PERCENT BONELESS ROASTS

		Mean squares	
Source	d.f.	Pounds of boneless roasts	Percent boneless roasts
Rep	2	1.52	12.09
Treatment	3	100.86**	63.65*
Rep x treatment	6	1.22	10.76
Sex	1	2.96	4.79
Rep x sex	2	2.67	15.40
Treatment x sex	3	2.97	12.28
Rep x treatment x sex	6	2.19	6.22
Error	45	4.37	11.13
Total	68		

* $P < .05$.
** $P < .01$.

roasts, but this difference was not significant. Treatment significantly ($P < .01$) influenced the amount of boneless roasts obtained from the carcass. The amount of boneless roasts was not influenced by the treatment x sex interaction.

The percent total pounds of boneless roasts from each carcass was significantly ($P < .05$) influenced by treatment but not by sex or the treatment x sex interaction. The combined mean for percent boneless roasts was 35.1% with a standard deviation of 3.8%. The means for the 95, 110, 125 and 140 pound groups were 37.9, 35.7, 34.4 and 33.6% boneless roasts per carcass. As live weight increases, the percent boneless roasts decreases ($P < .05$). This difference is indicative of a change in body composition with more fat being deposited with increased weight. No significant difference was shown between sexes, with wethers having 35.6% and ewes having 35.1% boneless roasts. The treatment x sex interaction did not significantly affect the percent of boneless roasts.

The amount of fat that a carcass contains is important to the entire industry from the feedlot to the dinner plate. The analyses of variance for fat for each cut and for total fat are found in table 10. Treatment significantly ($P < .01$) influenced the pounds of fat from all cuts except the breast and fore shanks. Sex or the treatment x sex interaction did not significantly influence the amount of fat for each cut. The means for leg fat, loin fat, rack fat, shoulder fat, flank and breast and fore shanks of each weight group are found in table 11.

Total pounds of fat for the 95, 110, 125 and 140 pound groups were 7.1, 10.8, 14.7 and 18.1 pounds, respectively. As live weight increased so did the amount of fat in the carcass. The overall mean for total pounds of fat was 12.8 pounds with a standard deviation of 5.5 pounds. Total fat trim was significantly ($P < .01$) influenced by weight but not significantly affected by sex or the treatment x sex interaction. However, wethers had 1.2 pounds less total fat than did ewes (12.1 vs. 13.3 pounds).

The analyses of variance for bone for each cut and for total bone are found in table 12. Treatment significantly ($P < .01$) influenced the pounds of bone in the rack and shoulder and significantly ($P < .05$) affected bone in the leg. No significant difference

TABLE 10. ANALYSES OF VARIANCE FOR FAT FOR EACH CUT AND FOR TOTAL FAT

Source	d.f.	Mean squares						
		Leg fat	Loin fat	Rack fat	Shoulder fat	Flank fat	Breast and fore shanks fat	Total fat
Rep	2	0.10	0.20	0.13	1.15	0.52	0.21	8.10
Treatment	3	18.97**	11.31**	17.54**	11.72**	9.40**	2.65	388.86**
Rep x treatment	6	0.56	0.46	0.21	0.71	0.26	0.68	10.63
Sex	1	0.10	0.53	2.01	0.47	2.28	0.02	23.23
Rep x sex	2	2.91	2.05	1.38	0.15	0.92	0.45	36.91
Treatment x sex	3	0.56	1.08	1.84	1.23	0.81	0.13	21.89
Rep x treatment x sex	6	0.84	0.59	0.67	0.27	0.35	0.36	12.15
Error	45	0.58	0.64	0.54	0.42	0.48	0.47	8.97
Total	68							

** $P < .01$.

TABLE 11. OVERALL MEANS, STANDARD DEVIATIONS AND TREATMENT MEANS FOR POUNDS OF FAT

Cut	Mean	S.D.	Mean/group (1-4)
Leg	2.5	1.3	1.3 2.1 3.0 3.6
Loin	2.2	1.1	1.2 1.7 2.4 3.0
Rack	2.3	1.3	1.1 1.8 2.2 3.5
Shoulder	2.5	1.0	1.5 2.1 2.8 3.4
Breast and fore shanks	1.8	0.7	1.3 1.8 2.1 2.1
Flank	1.6	0.9	0.8 1.2 2.1 2.4

TABLE 12. ANALYSES OF VARIANCE FOR BONE OF EACH CUT AND TOTAL BONE

		Mean squares					
Source	d.f.	Leg bone	Loin bone	Rack bone	Shoulder bone	Breast and fore shanks bone	Total bone
Rep	2	0.17	0.001	0.037	0.05	0.05	0.60
Treatment	3	1.43*	0.186	0.887**	3.12**	0.28	21.46**
Rep x treatment	6	0.10	0.025	0.024	0.28	0.07	0.26
Sex	1	0.45	0.004	0.002	0.10	1.21	4.29
Rep x sex	2	0.90	0.025	0.170	0.22	0.05	0.79
Treatment x sex	3	0.67	0.009	0.194	0.27	0.49	0.66
Rep x treatment x sex	6	0.75	0.063	0.091	0.21	0.26	1.17
Error	45	0.23	0.061	0.073	0.21	0.18	1.16
Total	68						

* P < .05.
** P < .01.

was found for loin and breast and fore shanks bone. Sex or the treatment x sex interaction did not affect amount of bone in each cut. The means for leg bone, loin bone, rack bone, shoulder bone and breast and fore shanks bones of each weight group are found in table 13.

Total pounds of bone for the 95, 110, 125 and 140 pound groups were 9.3, 10.1, 11.3 and 11.8 pounds, respectively. As live weight increased so did the amount of bone in the carcass. This increase of bone weight was significantly ($P < .01$) influenced by treatment but not by sex or the treatment x sex interaction. However, wethers had 0.5 pound more bone than the ewes (10.9 vs. 10.4 pounds). The mean total bone weight was 10.6 pounds with a standard deviation of 1.3 pounds.

An excellent measure of muscling is the amount of edible portion found in that carcass or carcasses. Trimmed weights include bone and some additional fat. Boneless roasts only tell how much boneless weight is in those cuts. However, E. P. is composed of the boneless roasts and all the useful lean.

The analyses of variance for E. P. weight of the leg, loin, rack, shoulder, flank, breast and fore shanks, total pounds of E. P. and the percent E. P. are found in table 14. The mean E. P. weight of the leg was 11.0 pounds with a standard deviation of 1.8 pounds. Pounds of E. P. were significantly ($P < .01$) influenced by treatment but not significantly affected by sex or the treatment x sex interaction. The E. P. weights of the leg were 9.6, 10.5, 11.8 and 12.1 pounds for the 95, 110, 125 and 140 pound groups. It was noted that

TABLE 13. OVERALL MEANS, STANDARD DEVIATIONS AND TREATMENT MEANS FOR POUNDS OF BONE

Cut	Mean	S.D.	Mean/group (1-4)
Leg	3.4	0.5	3.1 3.3 3.5 3.8
Loin	0.9	0.2	0.7 0.9 0.9 0.9
Rack	1.2	0.4	1.0 1.1 1.4 1.5
Shoulder	2.8	0.6	2.3 2.5 3.1 3.2
Breast and fore shanks	2.3	0.4	2.1 2.3 2.4 2.4

TABLE 14. ANALYSES OF VARIANCE FOR EDIBLE PORTION OF EACH CUT, TOTAL EDIBLE PORTION AND PERCENT EDIBLE PORTION

Source	d.f.	Mean squares							
		Leg E. P.	Loin E. P.	Rack E. P.	Shoulder E. P.	Flank E. P.	Breast and fore shanks E. P.	Total E. P.	Percent E. P.
Rep	2	1.06	0.03	0.08	1.57	0.32	0.30	1.28	12.12
Treatment	3	24.33**	2.29**	3.38**	29.13**	0.22	2.40	156.01**	322.55**
Rep x treatment	6	2.34	0.09	0.15	1.28	0.13	0.53	5.31	11.22
Sex	1	0.83	0.04	0.00	0.77	0.19	0.70	2.39	3.75
Rep x sex	2	0.15	0.76	0.02	6.61	0.38	2.15	22.22	122.73
Treatment x sex	3	0.73	0.36	0.13	5.07	0.23	1.14	8.55	6.09
Rep x treatment x sex	6	2.39	0.15	0.35	4.96	0.22	0.23	15.92	27.28
Error	45	1.82	0.33	0.35	3.27	0.36	1.09	9.68	21.28
Total	68								

** $P < .01$.

a larger difference existed between the 110 and 125 pound groups (1.3 pounds) than between the 95 and 110 pound groups (0.9 pound) or the 125 and 140 pound groups (0.3 pound).

The mean E. P. weight of the loin was 3.2 pounds with a standard deviation of 0.6 pound and was significantly ($P < .01$) influenced by treatment. The means for the 95, 110, 125 and 140 pound groups were 2.8, 2.9, 3.4 and 3.6 pounds, respectively. A larger difference was noted between the 110 and 125 pound groups (0.5 pound) than between the 95 and 110 pound groups or the 125 and 140 pound groups (0.1 and 0.2 pound, respectively). Sex or the treatment x sex interaction did not significantly affect the amount of E. P. found in the loin.

Treatment significantly ($P < .01$) influenced the E. P. weight of the rack, but sex or the treatment x sex interaction did not. The mean E. P. weight of the rack was 2.6 pounds with a standard deviation of 0.6 pound. The means of the E. P. weight of the rack were 2.2, 2.4, 2.9 and 3.2 pounds, respectively, for the 95, 110, 125 and 140 pound groups. A larger difference occurred between the 110 and 125 pound groups. A larger difference occurred between the 110 and 125 pound groups (0.5 pound) than between the 95 and 110 pound groups (0.2 pound) or the 125 and 140 pound groups (0.3 pound).

The weight of E. P. of the shoulder averaged 6.4, 7.0, 8.2 and 9.4 pounds for the 95, 110, 125 and 140 pound groups, respectively. It was noted that from 95 to 110 pounds an increase of 0.6 pound existed and there was twice this increase between the 110 and 125 pound groups (1.2 pounds) and between the 125 and 140 pound groups (1.2 pounds). Treatment significantly ($P < .01$) influenced the amount of E. P. obtained from the shoulder. Sex or the treatment x sex interaction, however, did not significantly affect the E. P. The overall average weight of E. P. from the shoulder was 7.8 pounds with a standard deviation of 2.0 pounds.

Edible portion weight of the flank and the breast and fore shanks was not significantly influenced by treatment, sex or the treatment x sex interaction. The means for each cut are shown in table 15.

Total E. P. was significantly ($P < .01$) influenced by treatment. Total E. P. for the 95, 110, 125 and 140 pound groups were 26.0, 28.0, 31.0 and 32.8 pounds. Here again the greatest difference was shown between the 110 and 125 pound groups with an increase of 3.0 pounds over the 110 pound group as compared to an increase of 2.0 pounds from 95 to 110 pounds and 1.8 pounds from 125 to 140 pounds. The overall mean was 29.4 pounds with a standard deviation of 3.9 pounds.

The percent of E. P. of a carcass is one of the most valuable estimates of carcass merit. This variable was significantly ($P < .01$) influenced by treatment but not significantly influenced by sex or the treatment x sex interaction. The mean for the entire experiment was 54.8% with a standard deviation of 5.97%. Means for the various weight groups followed a linear pattern as they decreased at a decreasing rate for each of the weight groups. The means were 60.3, 55.7, 52.6 and 50.3% for the 95, 110, 125 and 140 pound groups, respectively. Little difference (0.5%) was found between wethers and ewes (55.0% vs. 54.5%). As live weight increased, pounds of E. P. increased but the percent of E. P. decreased. These results agree

TABLE 15. OVERALL MEANS, STANDARD DEVIATIONS AND TREATMENT MEANS FOR POUNDS OF EDIBLE PORTION

Cut	Mean	S.D.	Mean/group (1-4)
Leg	11.0	1.8	9.6
			10.5
			11.8
			12.2
Loin	3.2	0.6	2.8
			2.9
			3.4
			3.6
Rack	2.6	0.7	2.2
			2.4
			2.9
			3.2
Shoulder	7.8	2.0	6.4
			7.0
			8.2
			9.4
Breast and fore shanks	3.6	0.9	3.8
			3.9
			3.3
			3.2
Flank	1.2	0.4	1.2
			1.2
			1.5
			1.3

with the reports of Kemp *et al.* (1969) and Lambuth *et al.* (1970). The increases of feed per pound of E. P. between the 95, 110, 125 and 140 pound groups were 2.9, 2.9 and 3.6 pounds. The amount of additional feed required to produce those additional pounds of E. P. is important to the producer.

Correlations

The simple correlation coefficients are shown in table 16. Average daily gain was not significantly correlated with slaughter weight or chilled carcass weight (-.25 and -.33). However, a significant ($P < .05$) relationship of 0.36 was shown between average daily gain and the percent E. P. of the carcass. This correlation is not high enough to consider using average daily gain as an indicator of E. P.; however, the faster gaining lambs exhibited a higher percent of E. P. than did the slower gaining lambs.

In general, the carcass weights and measures demonstrated a positive significant ($P < .01$) correlation with slaughter weight. Total pounds of E. P., total pounds of fat, total pounds of bone, total wholesale cut weight and trimmed leg weight were significantly ($P < .01$) correlated with slaughter weight (0.77, 0.85, 0.75, 0.95 and 0.81, respectively). Dressing percent, fat thickness and percent kidney fat were significantly ($P < .01$) correlated with slaughter weight (0.58, 0.53 and 0.45). The percent trimmed primal cuts had a negative correlation of -.60 with slaughter weight. The percent leg and loin and length had a low negative relationship to slaughter weight (-.28 and -.27, respectively). Loin eye area was significantly correlated with

TABLE 16. CORRELATION COEFFICIENTS BETWEEN VARIOUS CARCASS DATA AND SLAUGHTER WEIGHT, CHILLED CARCASS WEIGHT AND THE PERCENT EDIBLE PORTION OF CARCASS

	Slaughter weight	Chilled carcass weight	Percent E. P. of carcass
Percent E. P. of slaughter weight	-.32	-.23	0.73**
Rate of gain	-.25	-.33	-.36*
Dressing percent	0.58**	0.78**	-.55**
Fat thickness	0.53**	0.63**	-.58**
Loin eye area	0.58**	0.60**	-.34*
Total pounds E. P.	0.77**	0.80**	-.19
Total pounds fat	0.85**	0.93**	-.80**
Total pounds bone	0.75**	0.64**	-.44**
Total wholesale cut weight	0.95**	0.997**	-.73**
Percent four retail cuts	-.60**	-.66**	0.71**
Percent boneless roasts	0.52**	-.59**	0.74**
Trimmed leg weight	0.81**	0.87**	-.52**
Trimmed loin weight	0.36*	0.38*	-.28
Percent leg and loin of carcass	-.28	-.35*	0.34*
Pounds E. P., leg	0.68**	0.68**	-.20
Pounds E. P., loin	0.50**	0.47**	-.04
Pounds E. P., rack	0.62**	0.69**	-.32
Pounds E. P., shoulder	0.53**	0.58**	-.12
Pounds E. P., breast	-.17	-.16	0.18
Pounds E. P., flank	0.34*	0.36*	-.18
Leg probe	0.12	0.10	0.02
Loin probe	0.11	0.10	-.11
Rack probe	0.00	0.00	0.07
Shoulder probe	0.00	0.00	0.10
Percent kidney fat	0.45**	0.62**	-.40*
Length	-.27	-.28	0.50**

* $P < .05$. ** $P < .01$.

slaughter weight (0.58, $P < .01$) and to chilled carcass weight (0.60, $P < .01$).

Chilled carcass weight generally was significantly ($P < .01$) related to most carcass weights and measures. Dressing percent, total pounds of E. P., total pounds of fat and trimmed leg weight were highly correlated to chilled carcass weight (0.78, 0.80, 0.93 and 0.87, respectively). The total pounds of bone, fat thickness and percent kidney fat were significantly ($P < .01$) correlated with chilled carcass weight. Chilled carcass weight showed a significant negative relationship with percent trimmed primal cuts (-.66, $P < .01$) and percent leg and loin (-.35, $P < .05$). Length was negatively related to chilled carcass weight (-.28).

Total pounds of fat had a negative relationship with the percent E. P. of carcass weight (-.80, $P < .01$). Therefore, it can be stated that as fat increases the percent of edible portion decreases. It was noted that as the percent of edible portion increased most carcass weights and measurements decreased. However, the percent E. P. of slaughter weight was significantly ($P < .01$) related to the percent E. P. of carcass which was expected (0.73). The percent of trimmed primal cuts and the percent boneless roasts increased as the percent E. P. of carcass increased. The correlations of percent E. P. to percent trimmed primal cuts and percent boneless roasts were 0.71 and 0.74, respectively. High positive ($P < .01$) correlations of 0.77 and 0.80 existed between total pounds of E. P. and slaughter weight and chilled carcass weight, respectively. However, negative ($P < .01$)

correlations of -.66 and -.73 existed between percent E. P. of the carcass and slaughter weight and chilled carcass weight, respectively.

It appeared from these correlations that, by correlating percents to pounds, a negative correlation resulted. However, when data were expressed as a percent of carcass some adjustment was made for differences in live weight. At times it is desirable to look at pounds obtained and the cost to produce these pounds and fabricate them for sale to the consumer.

SUMMARY AND CONCLUSIONS

This study evaluated various quantity components of the carcass as influenced by the major variable live weight. The 72 lambs were divided equally according to sex and weaning weight into four weight groups. They were slaughtered at 95, 110, 125 and 140 pounds. Weights and measurements were taken 24 hours post slaughter and the carcasses separated into fat, bone and edible portion (E. P.).

As live weight increased, rate of daily gain, feed efficiency and percent E. P. decreased. There was a slaughter age difference of 105 days between the 95 and 140 pound groups. Ewes required 15 days longer, on the average, than wethers to attain their respective weights.

Dressing percent, which increased with live weight, was significantly influenced by weight groups only. Fat thickness and loin eye area were not influenced by live weight or sex.

As expected, total pounds of bone, fat and E. P. increased as live weight increased. Kidney fat weight increased significantly ($P < .01$) with live weight. Most carcass weights increased as live weight increased and little difference was observed between wethers and ewes.

The percent E. P. of carcass, percent trimmed primal cuts, percent boneless roasts and percent leg and loin of carcass all decreased as live weight increased. This was due to a change in body composition as more fat was deposited as weight increased.

The percent E. P. has been discussed as one of the most valuable estimates of carcass meatiness. The means of this variable decreased from 60.3% for the 95 pound group to 50.3% for the 140 pound group. Little difference was noted between ewes and wethers.

Fat is basically the largest single variable to affect percent E. P., percent leg and loin, dressing percent, kidney fat percent, percent trimmed primal cuts and percent boneless roasts. Fat also affects rate of gain and feed efficiency. As live weight increases so does fat and its effect on the above variables. However, it was observed in this study that there are individual lambs which gain rapidly, are efficient and reach the larger weights in less time than some lambs in the lighter weight groups. These heavy lambs were meaty, well muscled and had trim, desirable carcasses. Such lambs would be a producer, packer, retailer and consumer's dream. They need to be recognized and bred for in the future.

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APPENDIX

TABLE 1. MEANS LISTED ACCORDING TO WEIGHT GROUP AND SEX

Variable	Weight groups, lb. 95	110	125	140	Sex Wethers	Ewes
Rate of daily gain (lb.)	0.53	0.50	0.42	0.44	0.50	0.44
Animal age at slaughter (days)	133.6	167.7	210.0	238.0	182.4	197.2
Dressing percent	44.4	45.8	48.2	48.8	46.1	47.5
Fat thickness (in.)	0.38	0.45	0.45	0.60	0.45	0.49
Loin eye area (sq. in.)	1.8	1.8	2.0	2.1	1.9	2.0
Carcass length (in.)	26.0	24.5	24.0	24.0	24.7	24.6
Feedlot wt.	96.3	109.2	122.4	135.2	117.4	114.2
Slaughter wt.	83.2	93.4	108.0	118.8	102.2	99.4
Chilled carcass wt.	42.8	50.0	58.9	66.0	54.3	54.6
Wholesale leg wt.	13.6	15.7	17.9	19.8	17.0	16.5
Wholesale loin wt.	4.7	5.5	6.5	7.6	6.0	6.2
Wholesale rack wt.	4.4	5.4	6.5	8.5	6.0	6.4
Wholesale shoulder wt.	9.8	11.6	14.2	16.0	12.9	12.9
Total wholesale cut wt.	41.8	48.7	56.5	63.2	52.6	52.5
Total trimmed retail cut wt.	27.0	30.8	34.3	36.2	32.5	31.7
Percent trimmed retail cut	62.6	61.2	58.3	55.6	60.0	58.9
Trimmed leg wt.	12.0	13.5	14.5	15.0	13.8	13.6
Trimmed loin wt.	3.6	3.9	4.4	4.2	4.1	4.0
Percent leg	31.9	31.4	30.4	30.0	31.2	30.6
Percent loin	11.0	11.1	11.0	11.7	11.1	11.3
Percent leg and loin	42.9	42.4	41.4	41.7	42.3	41.9
Total boneless roasts wt.	16.3	17.9	20.2	21.8	19.3	18.8
Percent boneless roasts wt.	37.9	35.7	34.4	33.6	35.6	35.1
Kidney fat wt.	1.3	1.7	2.4	3.1	1.9	2.4
Percent kidney fat	3.1	3.4	4.1	4.6	3.4	4.1
Leg probe (in.)	0.43	0.36	0.32	0.43	0.43	0.35
Loin probe (in.)	0.53	0.60	0.44	0.51	0.47	0.57

TABLE 1 CONTINUED

Variable	Weight groups, lb. 95	110	125	140	Sex Wethers	Ewes
Rack probe (in.)	0.74	0.38	0.42	0.54	0.58	0.45
Shoulder probe (in.)	0.52	0.34	0.33	0.43	0.46	0.34
Pounds of leg fat	1.3	2.1	3.0	3.6	2.5	2.5
Pounds of loin fat	1.2	1.7	2.4	3.0	2.0	2.2
Pounds of rack fat	1.1	1.8	2.2	3.5	2.0	2.4
Pounds of shoulder fat	1.5	2.1	2.8	3.4	2.4	2.6
Pounds of flank fat	0.8	1.2	2.1	2.4	1.4	1.8
Pounds of breast and fore shanks fat	1.3	1.8	2.1	2.1	1.8	1.8
Total pounds of fat	7.1	10.8	14.7	18.1	12.1	13.3
Pounds of leg bone	3.1	3.3	3.5	3.8	3.5	3.3
Pounds of loin bone	0.7	0.9	0.9	0.9	0.9	0.9
Pounds of rack bone	1.0	1.0	1.4	1.5	1.2	1.2
Pounds of shoulder bone	2.3	2.5	3.1	3.2	2.8	2.7
Pounds of breast and fore shanks bone	2.1	2.3	2.4	2.4	2.4	2.2
Total pounds of bone	9.3	10.1	11.3	11.8	10.9	10.4
E. P. of leg (lb.)	9.6	10.5	11.8	12.1	11.1	10.9
E. P. of loin (lb.)	2.8	2.9	3.4	3.6	3.2	3.1
E. P. of rack (lb.)	2.2	2.4	2.9	3.2	2.7	2.7
E. P. of shoulder (lb.)	6.4	7.0	8.2	9.4	7.6	7.8
E. P. of flank (lb.)	1.2	1.2	1.5	1.3	1.4	1.2
E. P. of breast and fore shanks (lb.)	3.8	3.9	3.3	3.2	3.6	3.4
Total pounds of E. P.	26.0	27.8	31.0	32.8	29.6	29.2
Percent E. P. of carcass	60.3	55.7	52.6	50.3	55.0	54.4
Percent E. P. of slaughter wt.	26.8	25.7	25.3	24.4	25.3	25.7

TABLE 2. MEANS LISTED ACCORDING TO TREATMENT X SEX INTERACTION

	Wethers				Ewes			
Variable	95	110	125	140	95	110	125	140
Slaughter wt.	83.2	95.7	112.1	118.1	83.2	91.1	103.8	119.4
Dressing percent	44.2	45.8	47.5	46.7	44.7	45.7	48.8	50.8
Fat thickness (in.)	0.4	0.4	0.4	0.6	0.4	0.5	0.4	0.6
Rate of daily gain (lb.)	0.5	0.6	0.4	0.4	0.5	0.4	0.4	0.4
Loin eye area (sq. in.)	1.7	1.9	2.0	2.0	1.8	1.8	1.9	2.3
Total pounds fat	7.4	10.8	14.4	15.8	6.8	10.9	15.1	20.4
Total pounds bone	9.3	10.4	11.8	12.1	9.4	9.8	10.9	11.5
Total pounds E. P.	26.2	28.9	31.4	32.0	25.8	27.0	30.5	33.6
Percent E. P. of carcass	59.7	56.0	52.9	51.2	60.8	55.3	52.4	49.4
Percent kidney fat	3.0	3.4	3.5	3.9	3.1	3.4	4.8	5.3